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Applying the Soar Architecture to Model Cognitive Functions in a Kill Chain

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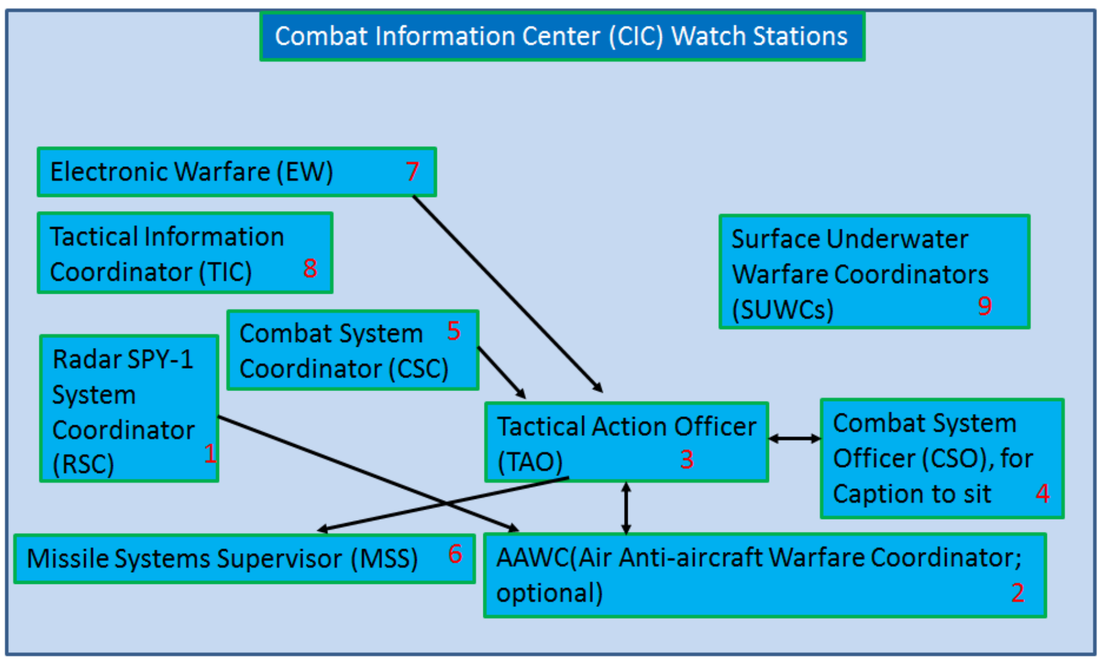
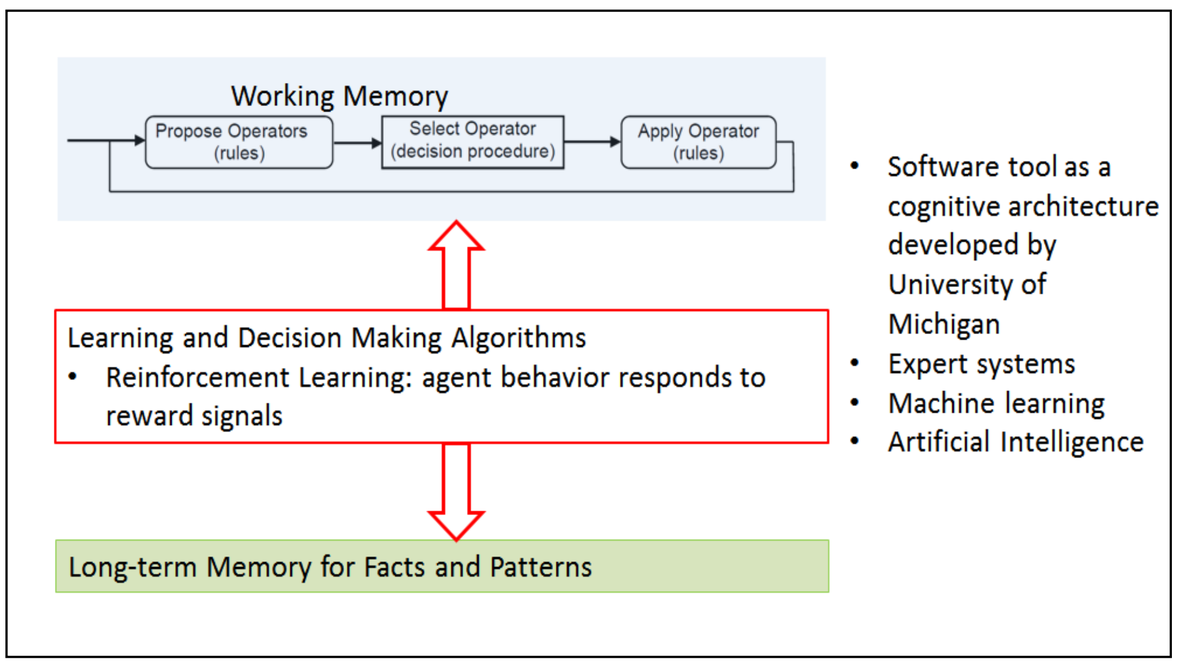
Concept Definitions

- Common Tactical Air Picture (CTAP)
  - Collect, process and analyze data from a vast network of sensors, platforms, and decision makers
  - Provide situational awareness to air warfare decision-makers
- Combat Identification (CID)
  - Locate and identify critical airborne objects as friendly, hostile or neutral with high precision



Complex Decision Making in a CID Process



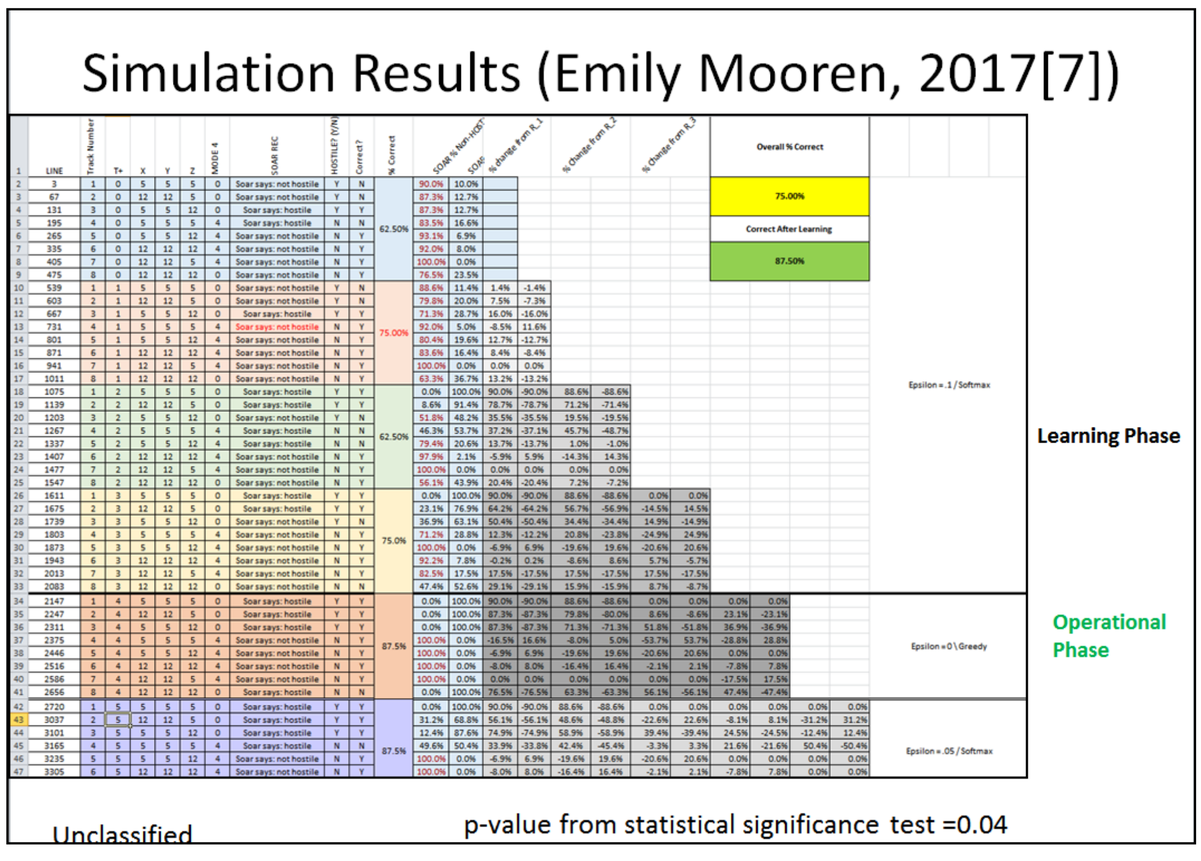
Soar and Reinforcement Learning

Core Questions Answered in The NPS Prototype

- Two core questions answered
  - Can Soar, incorporated in a CID process, learn and better use the existing knowledge models for CID cognitive functions, timely and automatic decision making?
  - Can Soar, incorporated in a CID process, learn from the feedback of human operators?
- Achieved a use case with three unclassified rules, a Java interface and simulation results summarized in a student thesis

Findings and Conclusions

- In the past, the NPS team worked with a thesis student, who was an experienced E-2 Mission Commander (MC), who demonstrated the feasibility of this idea and built a prototype Soar-RL model using simple three rules for a CID use case for this project.
- From the NPS prototype results, after a period of time for a learning phase, the Soar prototype allows the operator to gradually put a trained agent into the operational phase. The correct decision rate (i.e., deciding hostile or non-hostile for unknown airborne object) went from 62.5% to 87.5% with a statistical significance p-value<=0.04.
- In conclusion, the team is using the Soar-RL method, the team has characterized the problem space and has developed Soar production rule pseudocode as the procedural knowledge and basis for reasoning. We proved, in a small scale, that Soar can incorporate existing knowledge as production rules into long-term and short-term memories for decision making. The Soar-RL can improve, validate, simplify and even generate new rules based on feedback from external elements (e.g., human operators or other training data).



Future Work

- Incorporate the Soar prototype into the Naval Simulation System (NSS) and the Warfighting Impact by Simulated Decision Makers (WISDM).
- Scale up Soar models to machine learning current manual CID processes and extend Soar models for machine learning to other DoD applications of decision making that require overwhelming cognitive functions of experienced warfighters.

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